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Specification and Drawings, as originally filed, with Application for Patent Serial No: **2,413,438**, on December 3, 2002, by **CHEMCHAMP (BARBADOS) INC.**, assignee of Charles Harland, for "Constant Recycler".

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## ABSTRACT

A solvent vapour recovery system comprises a distillation module comprising a distillation chamber for a mixture of solvent and solvent waste and heating means for heating the chamber to vaporize the solvent. Conduit means may be provided for directing the vapour from the distillation chamber to a condenser, from which the condensed recovered solvent is collected. A waste chamber may be provided in communication with the distillation chamber for receiving waste therefrom, together with means for removal of the waste from said waste chamber.

# CONSTANT RECYCLER

## BACKGROUND OF THE INVENTION

Volatile solvents are used in many industrial processes in which the volatile solvent is used for cleaning purposes. As a result of such use the volatile solvent becomes contaminated with foreign matter. Such contamination may be in a variety of forms. For example, in a auto body shop, it would be in the form of paint residue from spray guns, which are normally cleaned with solvent in a gun washer. In an auto repair shop, the contaminants may well be oil and grease from the cleaning of mechanical parts. Due to the cost of such solvents, environmental concerns, and the cost of disposing of such contaminated volatile solvents, it is desirable to maximize the use that can be made of the solvent by removing the contamination from it by recycling it into the purified solvent form for further use in the industrial process. Various recycling systems exist for use in paint or body shops and as an example, reference is made to our published PCT application no. WO01/03810. However, these systems are quite large and expensive and are generally unsuitable for many small service bays. Therefore, it is common practice for repair shops to contract with a recycling company which will visit the shop periodically and collect the contaminated solvent for recycling elsewhere.

## SUMMARY OF THE INVENTION

It would therefore be desirable to provide a compact and inexpensive recycling system which could easily be placed in a service bay of an auto repair shop or similar type of establishment.

Accordingly, the present invention provides a solvent vapour recovery system which, in its first aspect, essentially relies upon the change of the vapour state in the recovery zone to function as a pump in sucking contaminated solvent into the recovery zone.

In a second aspect of the invention, the contaminated solvent is pumped into the recovery zone at a rate which is adjusted to match the rate at which recovered solvent is

removed from the recovery zone.

In a third aspect of the invention, the solvent in the distillation chamber is accumulated either in the chamber or in a separate waste chamber provided in communication with the distillation chamber for receiving waste therefrom, and is periodically drained.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 and 1A are schematic views of preferred embodiments of the vapour recovery system.

Figure 2 is a sectional view of a preferred embodiment of the distillation unit of the vapour recovery system illustrated in Figure 1.

Figure 3 is a sectional view of a preferred embodiment of the distillation unit of the vapour recovery system illustrated in Figure 1, in which the heating means is located at the upper end of the distillation chamber.

Figures 4 and 4A - 4C are schematic views of further embodiments of the vapour recovery system.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

A preferred embodiment of a vapour recovery system for solvents according to the invention is shown in Figure 1. As is conventionally found in auto repair shops and the like for the purpose of cleaning mechanical parts which are contaminated with oil or grease, there is provided a drum [11] containing solvent [14]. Extending downwardly into drum [11] is a conduit [17], the upper end of which communicates with the inlet of a pump [22]. The pump outlet communicates with a faucet or spray nozzle [23] for introducing solvent into a sink [16]. Contaminated solvent drains back into the drum [11] through a drain [15].

The vapour recovery system according to this embodiment comprises a distillation module [1] and contaminated solvent or solvent mixture f solvents to be recovered is heated in the distillation module [1] to generate solvent vapour. This solvent vapour then

exits through a conduit [12] which extends into the drum [11], below the surface of the solvent [14].

In operation, contaminated solvent is drawn through the conduit [12] into the distillation module [1], wherein it is distilled and the clean distillate returned via the conduit [12].

In the alternative embodiment illustrated in Figure 1A, the conduit [12] has a substantially vertical portion [12a] which extends downwardly into the container [11]. The bottom end of the conduit communicates with a U-shaped conduit portion [12b], which in turn communicates with an enlarged conduit portion [12c]. The portion [12c] is open at its upper end and the opening is covered by a screen [24]. Extending downwardly past the screen into the conduit portion [12c] is a drain pipe [15a] which communicates at its upper end with the drain [15] of the sink [16]. In this case, the contaminated solvent passes through drain pipe [15a] and enters the enlarged conduit portion [12c]. Some contaminants within the contaminated solvent are prevented from entering the clean solvent [14] by the screen [24] but, more importantly, the proximity of the drain pipe [15a] to the conduit portion [12c] increases the take up of contaminated solvent by the conduit [12] and decreases the amount of contaminated solvent entering the solvent [14].

In a preferred embodiment illustrated in Figure 2, the distillation module [1] comprises a distillation chamber [2] in which the contaminated solvent or solvent mixture [S] to be recovered is collected. The distillation chamber [2] is closed to prevent the escape of any vapour generated therein other than through the conduit [12] and to maitain a vacuum within the chamber. The size of the conduit [12] should be adequate to allow free passage of vapour from the distillation chamber [2] without resulting in a pressure build up in the distillation chamber [2]. Further, the conduit [12] is ideally positioned toward the upper end of the distillation chamber [2] since the hot vapour will rise. This distillation chamber [2] sits within a larger heating vessel [3] containing an oil bath [5]. The heating vessel [3] is provided with one or more heating elements [4] immersed in the oil and, in operation, each heating element [4] heats the oil [5], which in turn heats the distillation chamber [2] at least until the solvent [S] within the distillation chamber reaches its boiling point and vapour is generated.

It is essential that the oil [5] have a boiling point higher than that of the solvent to be recovered or, in the case of a solvent mixture, the boiling point of the highest boiling component of the mixture. In addition, the oil [5] should not be flammable within the temperature ranges in which the distillation module [1] will operate. In the preferred embodiment, the oil [5] in the heating vessel [3] will surround a substantial portion of the distillation chamber [2] (for example, to the level 5a in Figure 2) to ensure that there is sufficient heat to maintain the evaporated solvent in the vapour phase at least as far as the conduit [12].

A temperature probe [6] senses the temperature of the oil bath and when it is at or below a first pre-programmed level which is just below the boiling point of the solvent, a suitable control means (not shown) is employed to energize the heating elements [4] and initiate the heating cycle. During the heating cycle, the heating elements raise the temperature of the solvent [S] to a second pre-programmed level which is just above the boiling point of the solvent and as the solvent vaporizes, the vapour passes out of the distillation chamber [2] into the conduit [12]. The conduit [12] and the solvent [14] are below the boiling point of the solvent [S] and the vapour therefore condenses in the conduit (which may be provided with condenser coils in order to increase the condensation efficiency) and any uncondensed vapour will condense in the solvent mass [14].

It is also possible to adjust the power to the heating elements [4] in accordance with the temperature of the solvent in the manner described in our published PCT application no. WO01/03810 and using the control system described therein, which is incorporated herein by reference. This is especially desirable in the case where a mixture of solvents is to be recycled.

After the temperature rises to the second pre-programmed level, the power supplied to the heating elements is shut off by the control means, which initiates the cooling cycle, with the result that any remaining vapours in the chamber [2] are allowed to cool and condense back into the liquid S. This creates a vacuum in the chamber [2], which draws more contaminated solvent from the container [11] into the chamber [2]. The temperature continues to drop until the first pre-programmed level is reached, whereupon the control means turns the power on again to the heating elements [4] and the heating cycle begins again.

Thus, the negative pressure created in the distillation chamber [2] as it cools is used to draw more contaminated solvent for recycling into the distillation chamber [2] through conduit [12]. This acts as a natural pump and also allows a two-way flow through the conduit [12] of vapour away from chamber [2] and of contaminated solvent for recycling towards chamber [2], without the need for external pumps and separate inlet and outlet conduits, although external pumps and separate inlet and outlet conduits can also be employed, if desired, as will be explained hereinafter in connection with Figures 4 and 4A - 4C.

While the preferred embodiment describes the means for heating the distillation chamber [2] as comprising a heating vessel [3] containing one or more heating elements [4] immersed in oil [5], alternative means of heating the distillation chamber [2] are possible. In one alternative embodiment, the means for heating the distillation chamber [2] is an infrared lamp or microwave heating device [L] located toward the upper end of the distillation chamber [2] as illustrated in Figure 3. The heating provided by such a lamp or microwave heating device can be regulated by control of the intensity of the device. In this embodiment of the invention, the solvent [S] in the distillation chamber [2] is heated from the top down. This top heating provides the advantage that only the top layer of the liquid to be distilled needs to be heated to initiate distillation. Further, as the distillation progresses, it is only the energy of vaporization for the top layer of the liquid that needs to be provided to continue the distillation. Microwave heating also has the advantage that significant increase of the surface temperature of the solvent is avoided, which greatly reduces or eliminates the risk of auto-ignition.

Any waste which is not boiled off in the chamber [2] sinks down and is collected in a waste chamber [9] which is located below and in communication with distillation chamber [2] and is fitted with a drain tap or valve [19] for periodic removal of the collected waste. Alternatively, the waste chamber [9] may be omitted and the accumulated waste in chamber [2] may be drained directly through drain tap or valve [19]. The conventional arrangement for collection and disposal of solid wastes accumulated in the distillation chamber is a porous bag which lines the distillation chamber and which is removed and replaced periodically. The provision of a drain tap and optionally a waste chamber, (which could be used with any recycling system of this general type and not

solely with the arrangement described herein) is advantageous over the bag because it allows the waste to be flushed out through the drain tap without the necessity for opening the distillation chamber and replacing the bag, which is especially significant when the system relies upon the change of the vapour state in the distillation chamber to function as a pump in sucking contaminated solvent into the chamber. Also envisaged is a removable waste collection cartridge, which can be attached to the lower part of the distillation chamber (for example, using a spin-on cartridge in similar fashion to an automotive oil filter) and which can be removed from the distillation module and replaced by a fresh cartridge.

In the alternative embodiment shown in Figure 4, a vacuum pump P is provided in the conduit [12], the purpose of which is to suck vapour from the distillation chamber [2] and thereby lower the pressure within the distillation chamber and hence the boiling point of the liquid within the distillation chamber during the heating cycle. The pump is suitably configured to allow contaminated solvent to pass from the drum [11] to the distillation chamber [2] during the cooling cycle.

In the alternative embodiment shown in Figure 4A, conduit [12] is separated into feed conduit [212] and return conduit [112]. Vacuum pump P is provided in return conduit [112], the purpose of which again is to suck vapour from the distillation chamber [2] and lower the pressure within the distillation chamber [2] and hence the boiling point of the liquid within the distillation chamber. If desired, return conduit [112] may be led into a clean solvent collection drum (not shown) which is separate from drum [11]. Contaminated solvent passes from the drum [11] to the distillation chamber [2] through feed conduit [212].

In the further alternative embodiment shown in Figure 4B, conduit [12] is again separated into feed conduit [212] and return conduit [112]. In this case, a pressure pump P1 is provided in feed conduit [212], the purpose of which is to pump solvent from the drum [11] into the distillation chamber [2]. Again, if desired, return conduit [112] may be led into a clean solvent collection drum (not shown) which is separate from drum [11]. The rate of solvent feed to the distillation chamber by the pump P1 is adjusted to match the rate at which solvent is removed from the chamber by vaporization.

Figure 4C shows yet a further embodiment wherein both vacuum pump P and pressure pump P1 (again, located in return conduit [112] and feed conduit [212], respectively) are employed in order to increase the operating efficiency of the system.

The embodiments described in Figures 4A-4C have the advantage that no cool down cycle is required and the system can be run substantially continuously.

To further improve the operating efficiency of the embodiments described in Figures 4A- 4C, a restriction could be placed in an appropriate location in one or both of return conduit [112] and feed conduit [212], to control the internal pressure within the distillation chamber. For example, in Figure 4A, one or both of restrictions R and R1 could be placed in feed conduit [212] and in return conduit [112] (beneath pump P), respectively. The restrictions could be in the form of valves, which could be adjusted to regulate the internal pressure.

In each of the foregoing embodiments wherein the return conduit is separate from the feed conduit, the return conduit need not terminate beneath the surface of the solvent but can terminate above the surface to allow condensate to drip from the conduit into the solvent below.

As noted above, the system according to the invention is especially advantageous from the standpoint of simplicity and compactness, which makes it particularly suitable for such applications as auto repair shops. However, there are other significant advantages to the compact size, a major one of which is that the ratio of heating surface area to the volume of solvent is much higher than in larger units, which means that the surface temperature can be lower and the danger of auto-ignition of the solvent within the chamber reduced accordingly. Also, whilst the system has been described in the context of solvent recycling to remove waste, the "waste" can actually be valuable product which it is desired to recover. As an example, may be mentioned silver residue from a photographic film making process.

While only specific embodiments of the invention have been described, it is apparent that various additions and modifications can be made thereto, and various alternatives can be selected. It is, therefore, the intention in the appended claims to cover all such additions, modifications and alternatives as may fall within the true scope of the invention.

**CLAIMS:**

1. A solvent vapour recovery system which relies upon the change of the vapour state in the recovery zone to function as a pump in sucking solvent into the recovery zone.

2. A solvent vapour recovery system comprising:

a distillation module comprising a distillation chamber for a mixture of said solvent and solvent waste and heating means for heating said chamber to vaporize the solvent;

conduit means for condensing the vapour from said distillation chamber and directing the condensate into a solvent mass within a container.

3. A solvent vapour recovery system comprising:

a distillation module comprising a distillation chamber for a mixture of said solvent and solvent waste and heating means for heating said chamber to vaporize the solvent; and

means for draining said waste from said chamber.

4. A solvent vapour recovery system comprising:

a distillation module comprising a distillation chamber for a mixture of said solvent and solvent waste and heating means for heating said chamber to vaporize the solvent;

solvent waste collection means; and

means for draining said waste from said solvent waste collection means.

5. A solvent vapour recovery system comprising a recovery zone and means for pumping the contaminated solvent into the recovery zone at a rate which is adjusted to match the rate at which recovered solvent is removed from the recovery zone.

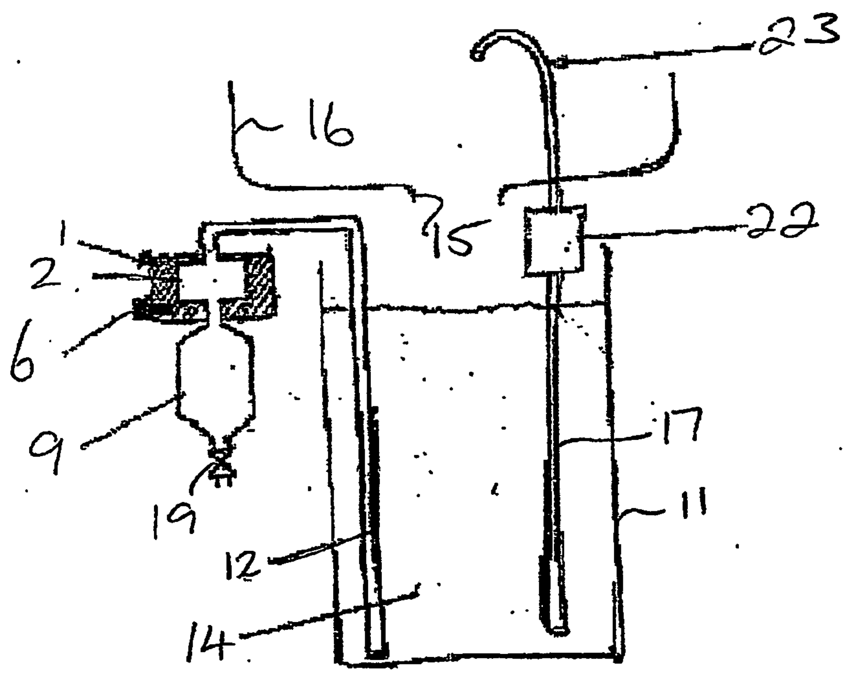


FIG. 1

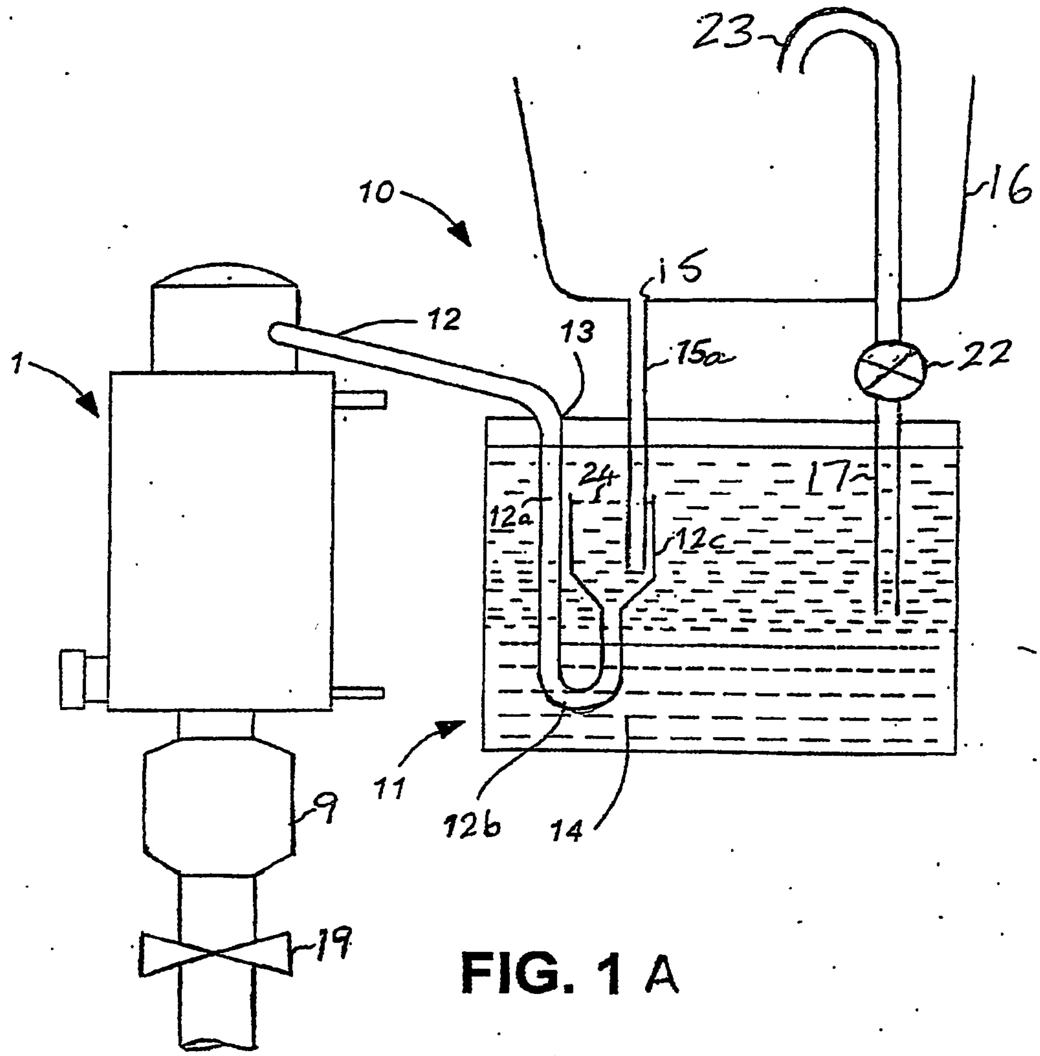


FIG. 1 A

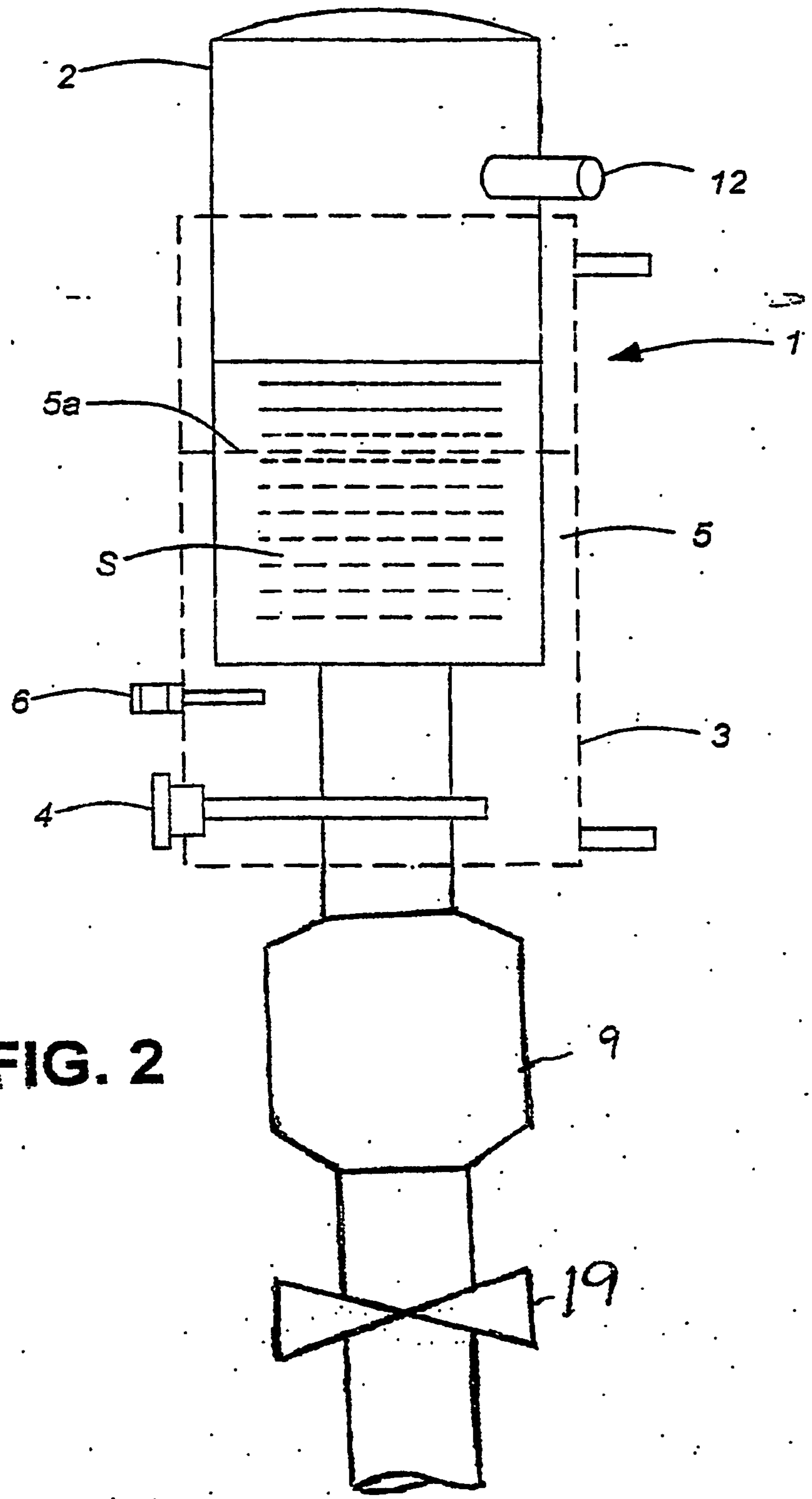


FIG. 2

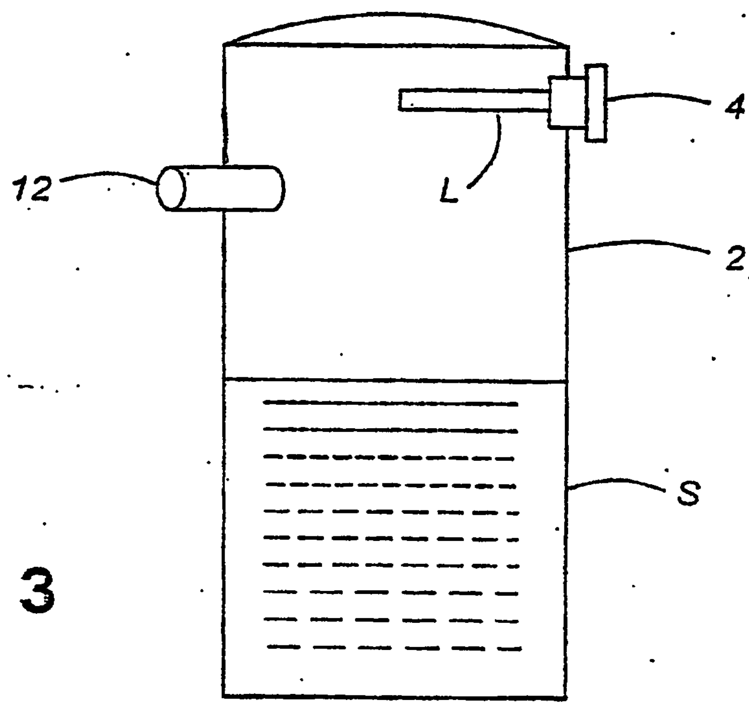


FIG. 3

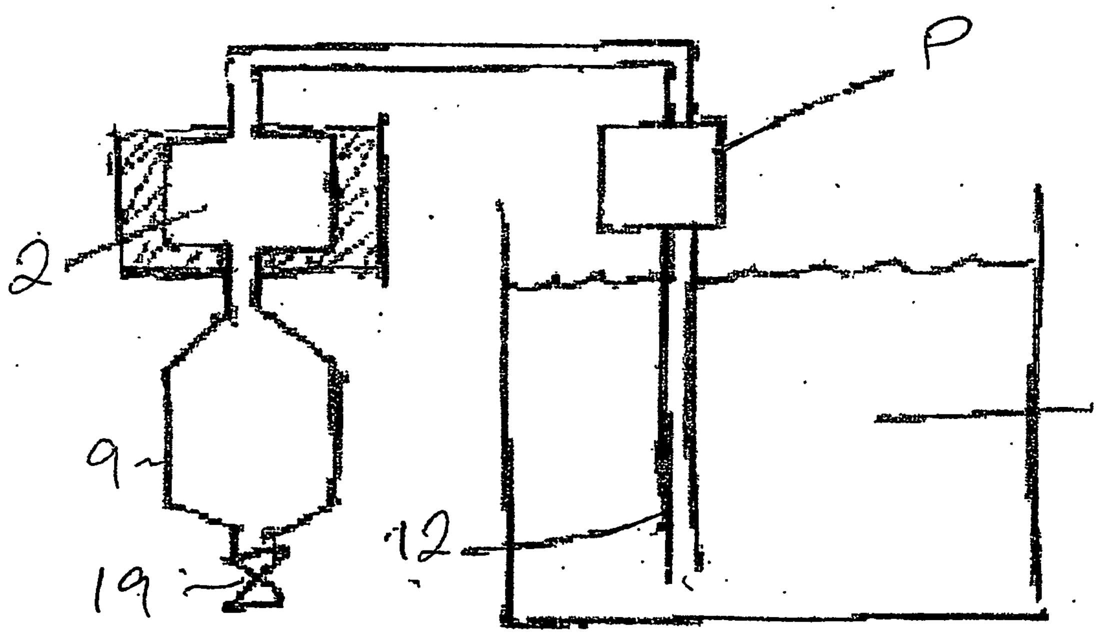


FIG. 4

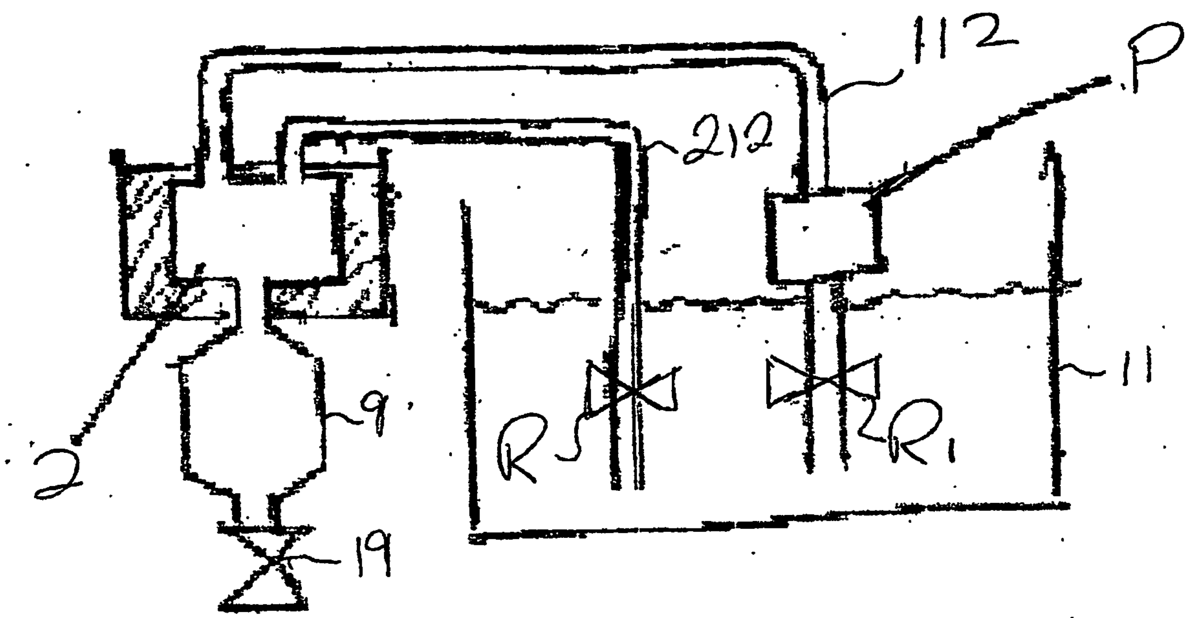


FIG. 4A

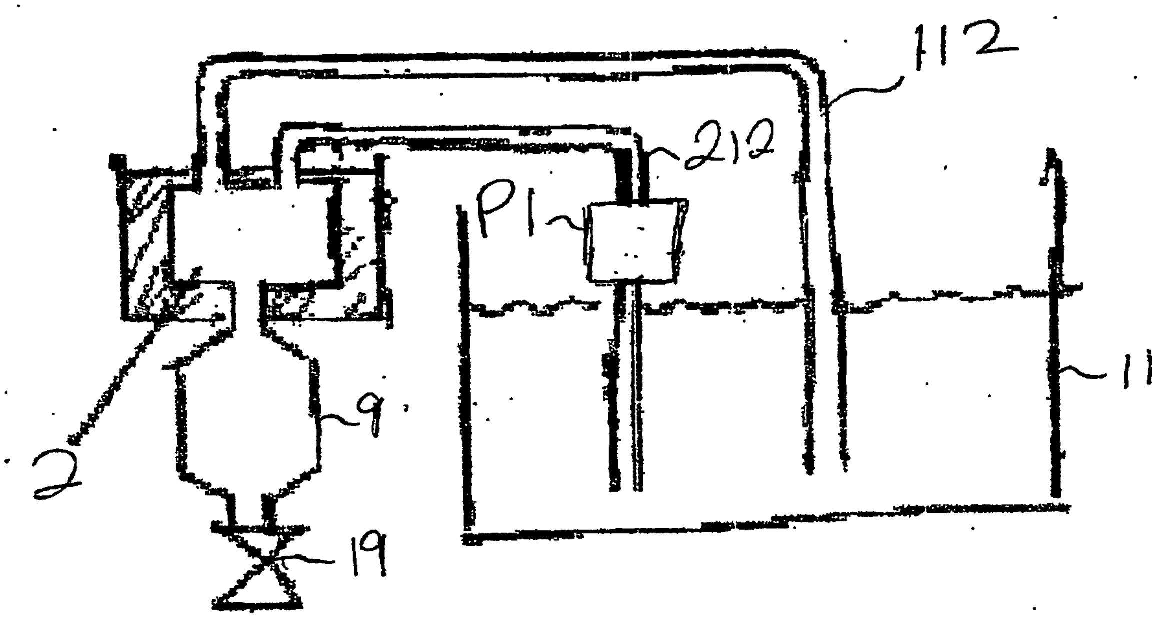


FIG. 4B

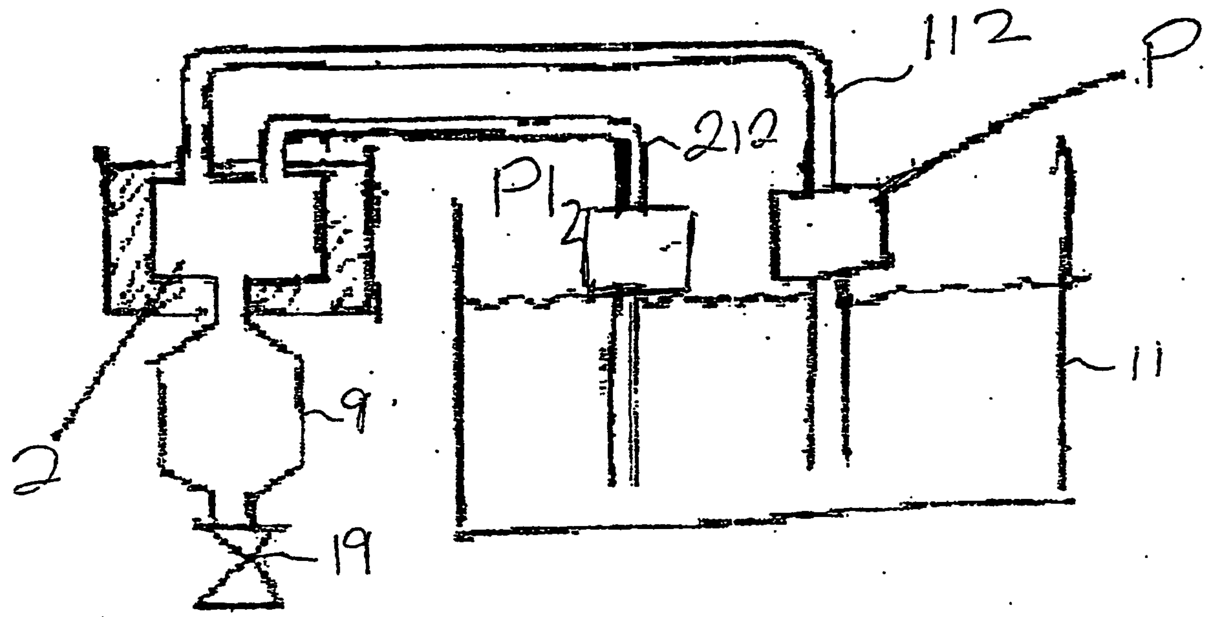


FIG. 4C